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Analysing the Impact of Technological Advancement on the Economy: An Input-Output Analysis

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Abstract:

In recent decades, Malaysia has significantly swift to technological advancements which revolutionise the business landscape and people's daily life. As a key driver of growth and innovation, Malaysia's technological progress impacts not only the technology sector but also other industries and the overall economy. Nevertheless, how do these advancements influence diverse sectors in the Malaysian economy. By using an input-output analysis, this paper investigates the interdependencies between various sectors and economic impacts within the Malaysia economy. Employing the Leontief input-output model, the study highlights the significant contributions of key technological sectors, notably Electronic components and boards, representing 49.3 per cent output changes following a 25.0 per cent increase in exports. The analysis also explores the importance of Electronic components and boards as well as Communication equipment and consumer electronics in driving digital transformation. Additionally, the study identifies the supporting roles of Wholesale & retail trade and transport sectors in the distribution and maintenance of technological products. By calculating backward and forward linkages and output multipliers, the research demonstrates the interconnectedness of these sectors and extensive economic impact. The findings suggest that focusing on key technological sectors is vital for fostering innovation and economic growth. The paper concludes with a recommendation for future research, emphasising the importance of understanding sectoral interdependencies to promote technological progress and achieve sustained economic benefits.

Keywords:

Input-Output Analysis, Technological Sectors, Economic Impact, Sectoral Interdependencies, Economic Growth

1. Introduction:

In today's swiftly changing economic landscape, information technology (IT) has emerged as a revolutionary force with significant consequences for many industries. The modern economy depends heavily on the IT sector, which promotes productivity, innovation, and industry competitiveness. With the advent of digital technology, Malaysia has witnessed a rapid transition to a knowledge-based economy backed by increasing reliance on IT to spur innovation and efficiency across a range of industries, including manufacturing, retail and services. The COVID-19 pandemic has further accelerated this dependence on IT, as businesses and individuals increasingly turn to digital solutions for remote work, online transactions, and communication.

The influx of IT into Malaysia has not only transformed the business landscape but has also influenced the daily lives of the people. From e-commerce platforms and digital payment systems to smart city initiatives and telemedicine services, IT has permeated various aspects of Malaysian society. Further, bringing about greater convenience, accessibility, and connectivity. The widespread adoption of smartphones and the internet hastened the digital revolution, making IT an integral part of everyday life in Malaysia.

As the global connectivity broaden, Malaysia's IT future looks promising. The collaboration between government agencies, educational institutions, and industry players has created a conducive environment for the development of a vibrant IT ecosystem, attracting both local and foreign investments. In relation to this, Malaysia has launching MyDIGITAL in 2021 - a national initiative which symbolises the aspirations of the Government to successfully transform Malaysia into a digitally-driven, high income nation and a regional leader in digital economy. With a focus on blockchain, Internet of Things (IoT), and cybersecurity, the country is set to lead in IT innovation as in line with MYDIGITAL aspirations to become a regional lead in digital economy and to achieve inclusive, responsible and sustainable socioeconomic development. Given the importance of the IT sector in Malaysia's economic scenario, it is vital to comprehend the specific challenges and opportunities it presents. Thus, the research question is: “What impact do these technological advancements have on various sectors within the Malaysian economy?”

2. Methodology:

This paper utilised data obtained from the Malaysia Input-Output (I-O) Table 2021 published by the Department of Statistics Malaysia (DOSM). The Leontief I-O model is adopted (Leontief, 1974) as below:

$$X = (I - A)^{-1}Y \quad (1)$$

where *X* is the output, *Y* is the final demand, *I* is the identity matrix, A is the input coefficient matrix, and $(I - A)^{-1}$ denotes the Leontief inverse matrix. For the purpose of this study, *Y* refers to exports.

The normalised backward and forward linkages are used to identify key sectors, given its high dependence on both upstream and downstream sectors. Normalised backward linkage formula can be defined as:

$$NBL_j = \frac{\sum_{i=1}^{n} l_{ij}}{\frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n} l_{ij}}$$

where, NBLj is the normalised backward linkage of sector j

lij is the ij element of Leontief inverse matrix,

n is the number of sectors

Normalised forward linkage formula can be defined as:

$$NFL_i = \frac{\sum_{j=1}^{n} g_{ij}}{\frac{1}{n}\sum_{i=1}^{n}\sum_{j=1}^{n} g_{ij}}$$

where, NFL_i is the normalised forward linkage of sector i

g_{ij} is the ij element of Gosh inverse matrix

n is the number of sectors

Output Multiplier

An output multiplier for a sector j is defined as the total value of production in all sectors of the economy that is necessary for all stages of production in order to produce one unit of product j for final use. It can be defined as:

$$O_j = \sum_{i}^{n} l_{ij}$$

where, O_j is the output multiplier of sector j

l_{ij} is the ij element of Leontief inverse matrix

n is the number of sectors

3. Result and Discussion:

The contribution of Information and Communication Technology (ICT) sector to the national economy was 13.6 per cent in 2022, influenced by the ICT Manufacturing industry, which had a higher double-digit growth of 21.3 per cent as compared to 11.0 per cent in 2021. Components and electronic boards, communication equipment, and consumer electronics continued to be the leading contributors to ICT Manufacturing, accounting for 35.7 per cent in total. The production of ICT products increased by 14.6 per cent (2021: 6.7%) and reached a value of RM263.9 billion in 2022. The growth was driven by the ICT Manufacturing industry (24.8%) and ICT Trade (12.0%) favourable performances. The total supply of ICT products was primarily dominated by domestic production, with a share of 71.7 per cent, followed by imports of ICT products (27.7%). In the meantime, exports accounted for 39.9 per cent of the total use with exports of ICT products climbed to RM444.5 billion in 2022, up 24.9 per cent from 13.1 per cent the previous year. Exports of ICT products accounted for 32.2 per cent of the total national exports. Meanwhile, imports of ICT products were RM308.8 billion, representing an

18.5 per cent increase driven by ICT services growth (19.5%). Imports of ICT products accounted for 24.7 per cent of the total imports in 2022. As a result, net exports of ICT products increased significantly, reaching RM135.7 billion in 2022.

Given the importance of ICT in driving the economy, technological progress has a substantial impact on various sectors, with electronic components and IT-related industries playing critical roles. Assuming a 25.0 per cent increase in the demand of exports, the Electronic components and boards sector stands out, experiencing an expected 49.3 per cent output increase, underscoring its vital contribution to technological infrastructure and innovation. Communication equipment and consumer electronics (12.7%) and Computers, peripheral, office equipment, and machinery (9.9%) are the important sectors in digital transformation. The Telecommunications & computer and information services sector, with a 5.6 per cent increase in output, is essential for enabling connectivity and data exchange. Additionally, the Wholesale & retail trade, repair of motor vehicles and motorcycles sector (6.3%) supports the sales of IT products to consumers. Transport sectors such as Land transport (0.4%) further contribute by ensuring the distribution of these technological goods **(Table 1)**.

Table 1: Output Changes in Selected Sectors Following a Demand Increase by 25.0 per cent

Sector	Expected Output Changes (%)
Electronic Components and Boards	49.3
Communication Equipment and Consumer Electronics	12.7
Computers, Peripheral, Office Equipment and Machinery	9.9
Wholesale & Retail Trade, Repair of Motor Vehicles and Motorcycles	6.3
Telecommunications & Computer and Information Services	5.6
Coke and Refined Petroleum Products	1.7
Electricity and Gas	1.4
Other Fabricated Metal Products	1.3
Monetary Intermediation	1.0
Specialised Construction Activities	0.8
Motor Vehicles, Trailers and Semi Trailers	0.6
Crude Oil and Natural Gas	0.6
Basic Precious and Other Non-Ferrous Metals	0.6
Electricity Distribution & Control Apparatus, Batteries and Accumulators	0.6
Professional	0.6
Land Transport	0.4
Basic Iron and Steel	0.4
Repair & Installation of Machinery and Equipment	0.4
Printing	0.3
Insurance/ Takaful and Pension Funding	0.2
Warehousing and Support Activities for Transportation	0.2

This analysis shows that a technological advancement does not only affects ICT related industries but also demonstrates a complex network of interconnected sectors. Key sectors like Electronic components and boards as well as Communication equipment and

consumer electronics play direct roles in driving technological innovation. Simultaneously, supportive sectors such as wholesale trade, financial services, transportation, and professional services are essential in facilitating the growth and adoption of new technologies.

The analysis of normalised backward and forward linkages further emphasises the importance of these sectors. Electronic components and boards exhibit strong linkages with a backward linkage of 1.107 and a forward linkage of 1.211, illustrating their substantial role as both consumers and suppliers of inputs. Communication equipment and consumer electronics show a backward linkage of 1.108 and a forward linkage of 1.047, reflecting their considerable dependencies on inputs while contributing significantly to other sectors. Computers, peripheral, office equipment, and machinery have a backward linkage of 1.144 and a forward linkage of 0.741, indicating that this sector relied on diverse inputs from various economic sectors **(Table 2).**

Table 2: Normalised Backward & Forward Linkages for Selected Sectors

Sector	Normalised Backward Linkage	Normalised Forward Linkage
Electronic Components and Boards	1.107	1.211
Communication Equipment and Consumer Electronics	1.108	1.047
Computers, Peripheral, Office Equipment and Machinery	1.144	0.741
Wholesale & Retail Trade, Repair of Motor Vehicles and Motorcycles	0.867	1.157
Telecommunications & Computer and Information Services	0.942	0.971
Coke and Refined Petroleum Products	1.061	1.372
Electricity and Gas	0.904	1.491
Other Fabricated Metal Products	0.920	1.382
Monetary Intermediation	0.761	1.353
Specialised Construction Activities	1.102	1.512
Motor Vehicles, Trailers and Semi Trailers	1.108	1.354
Crude Oil and Natural Gas	0.669	1.355
Basic Precious and Other Non-Ferrous Metals	1.057	1.281
Electricity Distribution & Control Apparatus, Batteries and Accumulators	1.074	0.980
Professional	0.859	1.444
Land Transport	1.079	1.149
Basic Iron and Steel	1.089	0.954
Repair & Installation of Machinery and Equipment	1.122	1.592
Printing	0.986	1.319
Insurance/ Takaful and Pension Funding	0.808	1.040
Warehousing and Support Activities for Transportation	1.106	1.062

Output multipliers provide insights into the economic impact of these sectors. Computers, peripheral, office equipment, and machinery, with an output multiplier of 2.032, demonstrate a high level of economic activity spurred by technological advancements. Telecommunications & computer and information services, with an output multiplier of 1.674, reflects its importance driven by technology. Similarly, Electronic components and boards, along with Communication equipment and consumer electronics, show output multipliers of 1.967 and 1.969, respectively, reflecting their reliance on technology and

their importance in economic activity. These multipliers reveal the interconnectedness of technology-driven industries and their considerable influence on various other sectors, showing how advancements in technology generate substantial economic benefits across the broader economy **(Table 3)**.

Table 3: Output Multipliers for Selected Sectors

Sector	Output Multiplier
Electronic Components and Boards	1.967
Communication Equipment and Consumer Electronics	1.969
Computers, Peripheral, Office Equipment and Machinery	2.032
Wholesale & Retail Trade, Repair of Motor Vehicles and Motorcycles	1.540
Telecommunications & Computer and Information Services	1.674
Coke and Refined Petroleum Products	1.886
Electricity and Gas	1.607
Other Fabricated Metal Products	1.634
Monetary Intermediation	1.352
Specialised Construction Activities	1.959
Motor Vehicles, Trailers and Semi Trailers	1.968
Crude Oil and Natural Gas	1.189
Basic Precious and Other Non-Ferrous Metals	1.878
Electricity Distribution & Control Apparatus, Batteries and Accumulators	1.908
Professional	1.526
Land Transport	1.917
Basic Iron and Steel	1.935
Repair & Installation of Machinery and Equipment	1.994
Printing	1.752
Insurance/ Takaful and Pension Funding	1.436
Warehousing and Support Activities for Transportation	1.966

4. Conclusion:

The analysis reveals that key sectors are highly affected by technological advancement, particularly Electronic components and boards, which output is expected to incline by 49.3 per cent to the demand changes, highlighting their crucial role in technological infrastructure and innovation. Sector namely Communication equipment and consumer electronics is pivotal in the digital transformation.

These findings also highlight how key sectors rely on technology to drive growth and underscore the importance of continued focus on these areas to foster innovation and economic development. Future research should examine the evolving relationships between these sectors and the impact of emerging technologies. Understanding these interdependencies is crucial for fostering technological progress and ensuring sustained economic benefits across industries.

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